इंटरनेट मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

"जानने का अधिकार, जीने का अधिकार"
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने को छोड नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"

IS 12746-4 (1993): Telecontrol equipment and systems, Part 4: Performance requirements [LITD 10: Power System Control and Associated Communications]

"ज्ञान से एक नये भारत का निर्माण"
Satyanarayan Gangaram Pitroda
"Invent a New India Using Knowledge"

Act Number 22 of 2005
The Indian Parliament
RIGHT TO INFORMATION

Made Available By
Public.Resource.Org

"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

BLANK PAGE

BRUTUM FULMEN

IGNORANTIA
JURIS
NON EXCUSAT

PROTECTED BY COPYRIGHT

IS 12746 (Part 4) : 1993
IEC Pub 870-4 (1990)
(Reaffirmed 2006)

भारतीय मानक

दूरनियंत्रण उपस्कर तथा तंत्र

भाग 4 कार्यकारिता अपेक्षाएँ

Indian Standard

TELECONTROL EQUIPMENT AND SYSTEMS

PART 4 PERFORMANCE REQUIREMENTS

UDC 621·398 : 620·16

© BIS 1993

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

September 1993

Price Group 10

Power Line Carrier Systems and Associated Telecontrol Equipment Sectional Committee, LTD 25

NATIONAL FOREWORD

This Indian Standard, which is identical with IEC Pub 870-4 (1990) 'Telecontrol equipment and systems — Part 4 : Performance requirements' issued by the International Electrotechnical Commission (IEC), was adopted by the Bureau of Indian Standards on the recommendation of the Power Line Carrier Systems and Associated Telecontrol Equipment Sectional Committee (LTD 25) and approval of the Electronics and Telecommunication Division Council.

The text of the IEC Pub has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

CROSS REFERENCES

In the adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC Pub 371 (1984) International electrotechnical vocabulary, Chapter 371 : Telecontrol	IS 1885 (Part 50) : 1985 Electrotechnical vocabulary : Part 50 Telecontrol	Technically equivalent
IEC Pub 870-1-1 (1988) Telecontrol equipment and systems, Part 1 General considerations. Section One — General principles	Doc LTD 25 (965) Telecontrol equipment and systems: Part 1 General considerations, Section 1 General principles (*under print*)	Identical
IEC Pub 870-5-1 (1990) Telecontrol equipment and systems, Part 5 Transmission protocols, Section One — Transmission frame formats	Doc LTD 25 (1583) Telecontrol equipment and systems: Part 5 Transmission protocols, Section 1 Transmission frame formats (*under print*)	Identical

The concerned Technical Committee responsible for preparation of this standard has reviewed the provisions of the following international publications and has decided that they are acceptable for use in conjunction with this standard.

IEC Pub 51 : Direct acting indicating analogue electrical measuring instruments and their accessories

IEC Pub 271 (1974) List of basic terms, definitions and related mathematics for reliability

IEC Pub 271A (1978) First supplement

IEC Pub 300 (1984) Reliability and maintainability management

IEC Pub 688 : Electrical measuring transducers for converting a.c. electrical quantities into d.c. electrical quantities

Only the English language text of the International Standard has been retained while adopting it in this Indian Standard.

IS 12746 (Part 4) :1993
IEC Pub 870-4 (1990)

Indian Standard

TELECONTROL EQUIPMENT AND SYSTEMS

Part 4: Performance requirements

INTRODUCTION

Reliable and secure remote monitoring and control of a geographically widespread process is the ultimate goal of a telecontrol system. This standard covers those aspects which contribute to achieving a level of system performance consistent with that goal.

The approach adopted in this standard has been to treat the subject of performance requirements on the basis of the inherent properties of telecontrol systems.

The inherent properties of a system are those intangibles, such as availability, time parameters, etc., which in many ways affect the overall system performance. During normal system operation, these properties and their effect on the system performance go largely unnoticed. Their real value is only noticed in exceptional circumstances, such as on detection of a fault, or when it is necessary to extend the system. The system performance, especially under these conditions, reflects the consideration given to these properties in the planning, design and manufacture of the equipment.

In determining the performance requirements for a particular telecontrol system, care should be taken to stipulate standards which are adequate for the specific application, without being tempted to place excessive demands. A balance should be found between the ideal requirements on the one hand, and the technical and financial consequences on the other hand.

1. Scope

This series of standards applies to telecontrol equipment and systems with coded bit serial data transmission for monitoring and control of geographically widespread processes. The scope of this standard embraces telecontrol systems in the restricted sense, as shown in IEC Publication 870-1-1, figure 2.

2. Object

This part deals with those characteristics which affect the performance of telecontrol systems and relates the characteristics to the application and processing functions.

The object of this part is to establish a set of rules which can be used to assess and specify the performance requirements of telecontrol systems.

It is intended that this part serves as a common platform for the system planner and the supplier or manufacturer of telecontrol systems. The system planner will find the contents helpful in determining the requirements for a particular telecontrol system. In addition, these rules provide a means of comparing the products of different suppliers. The supplier or manufacturer will find guidelines for the system design and a base for classification of system performance.

This part comprises a main body, which contains the actual standard, together with two appendices, which contain further information and recommendations.

The main body is devoted chiefly to a treatment of the various characteristics as operational parameters. A short description of each operational parameter is followed by a list of the necessary performance requirements and, where feasible, a classification of the operational parameters in performance classes.

The performance classes serve to specify the system requirements for a particular application and to evaluate the system performance of different telecontrol systems.

The performance classes used are to be optimized for each application and agreed upon between the user and the supplier.

3. Classification of operational parameters

This clause covers those properties which influence the performance of telecontrol systems. Appropriate requirements and, where feasible, performance classes have been specified for each of the properties covered.

The classification ratings given apply in general to the performance of the units of the overall system. The performance of the overall system shall be derived from the performance of all components of a telecontrol system (in the restricted sense), excluding the process and the operator's equipment. Certain properties, however, such as reliability and availability, can be applied as performance criteria to individual items of equipment. The components of an overall system are, for instance:

- substations;
- nodes;
- transmission lines;
- central processor;
- man/machine interface.

The requirements for a particular telecontrol system are dependent on the specific application and are invariably subject to agreement between supplier and user.

3.1 *Reliability*

Reliability is defined as a measure of an equipment or system to perform its intended function under specified conditions for a specified period of time (see IEC Publications 271, 271A and 300). It is a probability figure, based on failure data and length of operating time.

The reliability of a telecontrol system is expressed by the "mean time between failures" in hours (MTBF), and can be calculated from the reliability figures of the individual system components (see the standards of Technical Committee No. 56).

The reliability of a system depends on the following factors:

- the reliability of the system equipment and the software;
- the configuration of the system.

Measures which may enhance the reliability are listed in appendix A, clause A.1.

3.1.1 *Reliability requirements*

The overall system reliability and partial reliabilities of certain specified sections of the telecontrol system are to be calculated by the supplier from the reliability figures of the individual components, and proved against the actual performance in the field over a given trial period. The start and duration of the trial period should be agreed upon between the supplier and the user and should exclude the early failure period.

The equipment supplier should provide on request failure distribution data for all components, assemblies and units which, on failure, could cause loss of a function or malfunction of the system.

The failure modes and the effects of failures on the system performance shall be analysed by the supplier and the results made available on request.

3.1.2 *Reliability classes*

In the reliability classes provided in table 1, the values given refer to the reliability of the units of the overall system.

Table 1 - Reliability classes

Reliability class	MTBF
R1	MTBF ≥ 2 000 h
R2	MTBF ≥ 4 000 h
R3	MTBF ≥ 8 760 h

3.2 *Availability*

The availability of a unit of a system characterizes its ability to perform its required function at any given moment.

The availability is a probability figure which concerns operation at a given instant, in contrast to reliability which concerns operation over a given period.

The availability of a unit of the overall system, expressed in "A", may be calculated using the equation:

$$A = \frac{\text{uptime}}{(\text{uptime} + \text{downtime})} \cdot 100\% \qquad (1)$$

In applications where outages due to preventive maintenance degrade system operation, the downtime in equation (1) should be the sum of the corrective maintenance and the preventive maintenance.

For hardware design analysis and for prediction of availability of system subassemblies and units, equation (2) shall be used, utilizing MTBF and MTTR as defined in subclauses 3.1 and 3.3 respectively:

$$Ap = \frac{\text{MTBF}}{(\text{MTBF} + \text{MTTR})} \cdot 100\% \qquad (2)$$

where

Ap is the predicted availability.

This equation governs the relationship between the values given in tables 1 to 4. Therefore these values may not be combined arbitrarily.

Measures aimed at improving the system availability are given in appendix A, clause A.2.

2.1 *Requirements*

The class or classes of availability applicable to the telecontrol system and subsystems under consideration are subject to agreement between supplier and user.

The availability of telecontrol systems or equipment already in operation, shall be calculated using equation (1), on the basis of statistics provided by operating and maintenance records. The records should cover a time period of not less than 6 months for systems and 12 months for equipment, starting after elapse of the early failure period.

For equipment not yet installed, equation (2) should be used to calculate the predicted availability of the overall system as well as the major system components, such as master station equipment, outstation equipment, etc., and computer peripheral devices. The calculated results should be checked against the performance in the field once the equipment has been operating for the time required to exclude the early failures.

The consequence of outages of individual system elements or functions on the overall system availability and of planned preventive maintenance should be mutually agreed upon between the user and the supplier.

3.2.2 *Availability classes*

In the availability classes provided in table 2, the values given, unless otherwise stated, refer to the availability of the units of the overall system.

Table 2 - Availability classes

Availability class	Availability A
A1	A ≥ 99.00%
A2	A ≥ 99.75%
A3	A ≥ 99.95%

3.3 *Maintainability*

Maintainability is the ability of a system or equipment under given conditions of use, after detection of a fault, to be restored to full working order and to be maintained during normal working operation.

The maintainability, whilst being influenced by the respective maintenance organization, is mainly dependent on the serviceability and thus on the layout of the equipment, together with the diagnostic facilities provided.

Maintainability is expressed by the "mean time to restoration" in hours (MTTR), which is given by the sum of the following components:

- administration time: the time interval between detection of a fault and notification of the maintenance service;
- transport time: the time interval between notification of the maintenance service and the arrival on site of the maintenance personnel together with the necessary equipment;
- mean repair time (MRT): the mean time required by trained maintenance personnel on site, equipped with replacement parts and the recommended test equipment, to diagnose and to rectify the fault, including retesting the equipment.

The MTTR, as defined above, is without the administration time significant only for telecontrol systems and equipment which are maintained by the supplier. For installations maintained by the user, the supplier only has influence over the repair time, the administration and transport times being dependent on the user's maintenance organization.

The serviceability of equipment, as a design feature, shall be considered during the initial design and development phase and thus it is important that serviceability requirements be established prior to the release of the equipment specifications.

Measures which may enhance the serviceability and thus the maintainability of equipment are listed in appendix A, clause A.3. Normally, only the producer can give the MRT figure.

3.3.1 *Requirements*

Equipment complying to this standard shall be maintainable by trained personnel at service facilities and in the field.

The class or classes of maintainability applicable to the telecontrol system and subsystems under consideration are subject to agreement between supplier and user.

The MTTR values quoted by the supplier shall be based on available maintenance statistics.

The supplier shall, upon request, provide a list of test equipment and quantities of replacement parts deemed necessary for the maintainability class(es) agreed upon. The extent of the spare parts shall take into consideration the time required to repair a faulty component (field and/or factory repair) and return it to a serviceable condition.

3.3.2 *Maintainability classes*

In order to differentiate between the mean time to restoration (MTTR) and the mean repair time (MRT), separate classifications have been provided for both properties, as shown in tables 3 and 4.

Table 3 - Maintainability classes

Maintainability class	MTTR
M1	MTTR ≤ 36 h
M2	MTTR ≤ 24 h
M3	MTTR ≤ 12 h
M4	MTTR ≤ 6 h

Table 4 - Repair time classes

Repair time class	MRT
RT1	MRT ≤ 24 h
RT2	MRT ≤ 12 h
RT3	MRT ≤ 6 h
RT4	MRT ≤ 1 h

3.4 *Security*

The security of a telecontrol system can be defined as its ability to avoid placing the controlled system in a potentially dangerous or unstable situation. It deals with the consequences of failures, arising out of malfunctions of the telecontrol equipment, undetected information errors as well as information losses.

The consequence of a failure may depend on the state of the power system at the instant of failure. A dangerous situation can arise out of a combination of a failure of the telecontrol system with a particular situation of the power system. In such cases, the probability of occurrence of a dangerous situation is the product of the probability of occurrence of the failure and the probability of occurrence of the particular situation in the power system, provided that the two occurrences are independent of each other.

Measures to enhance the security are given in appendix A, clause A.4.

3.5 *Data integrity*

Data integrity is defined as the unchangeability of an information content between a source and its destination. In telecontrol systems, data integrity concerns the probability of undetected errors resulting in wrong information about actual process states in the monitoring direction or unintended actions in the control direction of the system.

Data integrity classes are provided which specify upper limits of undetectable information error probabilities, on the path from an information source to its destination, covering data acquisition, processing and transmission. The error probabilities take into account the residual error probabilities (IEV 371-08-06) and the probability of residual information losses (IEV 371-08-10).

Publication 870-5-1 of this series of standards specifies in sub-clause 4.1 three data integrity classes for quantified upper limits of undetected message errors ("residual message errors"), depending on the bit error rate on the transmission channel. This way of specifying data integrity classes for telecontrol transmission channels is necessary because the environmental conditions causing disturbances on transmitted data are to a great extent unpredictable and the means of protecting data against undetectable errors by coding methods are limited.

3.5.1 *Requirements*

The average bit error rate of telecontrol channels (IEV 371-08-01) operating with correctly adjusted signal and circuit parameters and provided with appropriate screening should be smaller than $p = 10^{-4}$.

Note.- The quality of the transmission channels can be monitored by periodically checking the number of message errors detected. If this number exceeds a limit corresponding to the bit error rate $p = 10^{-4}$, preventive maintenance of the channel circuit is required.

The value $p = 10^{-4}$ (see figure 1 of Publication 870-5-1) is used as reference for the specification of upper limits of undetectable information errors over the whole path from source to destination which includes the data terminating equipment used for data acquisition and the equipment provided for data evaluation and display.

The corresponding data integrity classes are specified in table 5.

Measures to enhance the data integrity are given in appendix A, clause A.5.

3.5.2 *Data integrity classes*

The following integrity classes apply to the information transfer from a source to its destination and refer to:

- the probability of undetected falsification of information, and
- the probability of undetected information loss.

Table 5 - Data integrity classes

Data integrity class	Residual information error probability IE
I1	$IE \leq 10^{-6}$
I2	$IE \leq 10^{-10}$
I3	$IE \leq 10^{-14}$

3.6 *Time parameters*

The time parameters referred to are those concerned with the performance of telecontrol systems, together with the transfer and processing of information.

In the field of telecontrol, the most crucial time parameter involves the time taken to transfer information from the source to the destination. Designated as the overall transfer time, it is defined in IEV 371-08-15 as:

"The time duration by which information is delayed after the actual event in the sending station and until presentation at the receiving station".

The overall transfer time is used as a performance rating factor for telecontrol systems, as well as to specify the major time requirements for a particular application.

In a general sense, the overall transfer time is given by the sum of the times taken by the information to pass through the individual sections of the telecontrol system. It reflects not only the equipment performance, but is also influenced by such factors as:

- the data network configuration;
- the telecontrol transmission methods;
- the transmission line bandwidth;
- the preprocessing functions in the sending station;
- the processing functions in the receiving station;
- the noise level on the transmission line;
- the accumulation of events in a given time period;
- the priority facilities of the data transmission protocol.

The overall transfer time can only be used with reference to a specific telecontrol system and thus does not lend itself to classification.

Other relevant time parameters, as defined in IEV (371-08-16 to 371-08-22), are:

- telecontrol transfer time;
- maximum and average transfer time;
- start and restart time.

The various types of information place different demands on the time requirements. Thus, in the following subclauses, each information type is dealt with separately.

3.6.1 *State information*

The state information may be ordered in two general categories:

- high priority state information such as circuit-breaker indications and main alarms;
- low priority state information such as isolator indications and alarms of minor significance.

The essential difference between these two categories concerns the overall transfer time. The high priority information has to be transferred as fast as possible and thus should have the shortest overall transfer time.

In addition to the overall transfer time, the following time parameters are of importance in the processing of state information:

Separating capability (IEV 371-05-01)

The minimum time by which events must be separated such that the sequence of their occurrence is determined correctly.

Time resolution (IEV 371-05-03)

The minimum time by which two events must be separated in order that the corresponding time tags be different.

Suppression time

Time period during which the acquisition of erroneous changes of states, generated by noise or contact bounces, is suppressed.

Acquisition time

The minimum time duration of a state information required for correct detection and processing.

Approved methods of determining the performance and the information transfer capacity of telecontrol systems are given in appendix A, clause A.6.

3.6.1.1 *Requirements*

The telecontrol equipment shall detect and process any change of a state information which is maintained for longer than the given acquisition time.

The ratio of the acquisition time to the suppression time shall be $\leq 2:1$. The actual suppression time(s) used for a particular application shall allow for the maximum contact bounce time of the process input equipment.

The telecontrol equipment shall be capable of detecting and processing the transitions of the input signals from the ON to OFF state as well as from the OFF to ON state. For particular signals, only the transition from OFF to ON is a relevant information (e.g. incremental information).

3.6.1.2 *Time requirement classes*

The time requirements applicable to the processing of state information are subject to mutual agreement. The following tables can be used to specify the corresponding requirements.

Table 6 - Separating capability classes

Time parameter	Time class requirement				
Separating capability	Unit	SP1	SP2	SP3	SP4
	ms	≤ 50	≤ 10	≤ 5	≤ 1

Table 7 - Time resolution classes

Time parameter	Time class requirement				
Time resolution	Unit	TR1	TR2	TR3	TR4
	ms	≤ 1 000	≤ 100	≤ 10	≤ 1

3.6.2 *Command information*

The outstation shall interface with at least two kinds of controlle devices:

- fast moving devices, which reach a new determined state in less than 250 ms;
- slow moving devices, which move in times from 250 ms to several minutes.

The overall transfer time for commands shall be as short as possible, which requires that commands be processed and transmitted at high priority.

3.6.2.1 *Requirements*

The operator shall be able to supervise the execution of an initiated command. This requires adequate data transmission supervisory functions, as well as return information or measurands in order to confirm the following:

- acceptance and correct transfer of the command message by the telecontrol equipment;
- the execution of the initiated action in the peripheral equipment.

In case of slow or very slow moving devices, the operator should be able to observe the intermediate state information (e.g. the transit state of a slow moving isolator). If the intermediate state persists for longer than a specified time, a faulty state information should be generated.

3.6.2.2 *Time requirement classes*

No time requirement classes have been provided for the processing of command information. The supplier and the user are to agree mutually on the relevant time values.

3.6.3 *Measured values and set point commands*

The time parameter associated with the processing of measured values and set point commands is the overall transfer time (IEV 371-08-15), see subclause 3.6.

The overall transfer time laid down for a telecontrol system depends largely on the particular requirements of that system and is usually in the range of seconds up to minutes.

3.6.4 *Telecounting (transmission of integrated totals)*

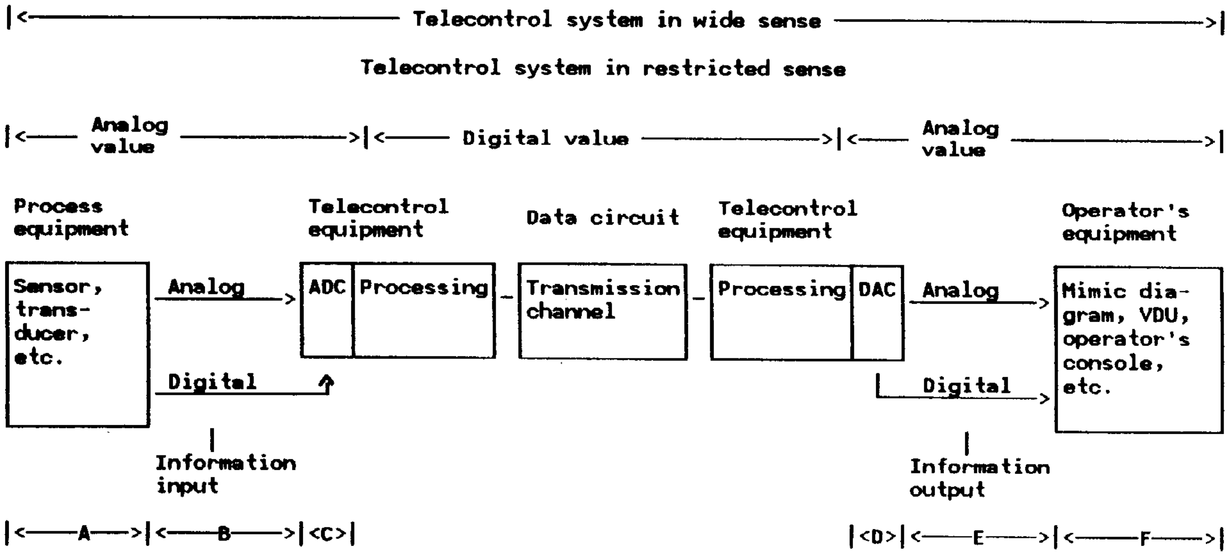
Integrated totals are supplied to the telecontrol equipment in the form of digital coded values or as incremental pulses which are added together in internal counters. The storage command for the integrated totals may come from the local counter units, or may be transmitted to the outstation by an interrogation command. It should be ensured that the further processing of the data be managed in less than a given time and that the storage command be sent simultaneously to a specified number of outstations.

It has to be ensured that, under specified worst case transmission conditions, the time required for processing and transmission of the integrated totals is shorter than the specified totalizing period. In addition, the data integrity requirements have to be fulfilled.

3.7 *Overall accuracy*

The overall accuracy of processed information is defined as the deviation between the destination and the source values, expressed in per cent of the nominal full range value. This applies to all information which, between the source and the destination, undergoes a conversion from the analog to the digital representation, or vice versa.

A treatment of the overall accuracy involves a consideration of the individual sections of the information path, from the source to its destination.



where:

ADC = analog digital converter
DAC = digital analog converter
VDU = visual display unit.

Figure 1 - Processing of analog information

The term "accuracy class" actually refers to the error produced in the equipment, i.e. class 1 is equivalent to an error of 1%.

If the individual error sources are random and independent of each other, the overall error E is calculated by:

$$E = \pm \sqrt{E_A^2 + E_B^2 + \dots + E_F^2} \qquad (1)$$

where

E_A, E_B ..., etc., are single errors corresponding to the sections in figure 1.

3.7.1 *Accuracy requirements*

The accuracy required for the acquisition, transmission and output of measured values, set point commands and integrated totals should be related to the requirements of the process.

In order to attain the required overall accuracy, the accuracy requirements of the various sections of figure 1 shall be higher than the specified overall accuracy.

Further information concerning the overall accuracy is given in appendix A, clause A.7.

3.7.2 *Overall accuracy classes*

The overall accuracy classes used are to be specified on the basis of the following table:

Table 8 - Overall accuracy classes

Accuracy class	Overall error E
A1	E ≤ 5.0%
A2	E ≤ 2.0%
A3	E ≤ 1.0%
A4	E ≤ 0.5%
Ax	Special class (e.g. digital input values)

3.7.2.1 *Telecontrol equipment*

The assessment of the accuracy class shall include the errors induced in the equipment due to component tolerances, equipment ageing, environmental conditions, linearity errors and power supply tolerances. Excluding all equipment errors, the analog to digital conversion as well as the digital to analog conversion has an inherent error of ±1/2 digit. This gives a direct relationship between the number of digits in the digital coded information and the corresponding accuracy class.

Class Ax has been included for information provided in digital form which excludes conversion errors.

Information input - Section C of figure 1

The analog-to-digital converter (ADC) converts the measured analog values and presents the result as digital coded information.

The input circuit and the ADC shall maintain the accuracy over the nominal range.

The overload condition is to be indicated by a specified maximum digital value with the correct sign.

Processing should not degrade the accuracy of the digital value.

Information output - Section D of figure 1

In this section, the digital information is converted to equivalent analog values by a digital-to-analog converter (DAC).

The accuracy is guaranteed only up to the burden specified. The DAC shall not be damaged by short circuit or open circuit of the load.

3.7.2.2 *Other telecontrol system equipment*

This subclause refers to the process equipment, operator's equipment and the cabling shown in sections A, B, E and F of figure 1.

Sections A and F

Sensors, transducers and operator's equipment should be chosen according to the relevant IEC standards (e.g. IEC Publications 51 and 688 of TC 85).

Sections B and E

Noise may degrade the information signals in the cables. Suitable screening and cable laying shall ensure that the influence of noise on the measuring signals is kept as small as possible and does not degrade the accuracy.

4. Expandability

Most telecontrol equipment, during the course of its lifetime, will have to be extended or modified to accommodate the changes made to the process it serves.

The expandability of a telecontrol system is the characteristic which expresses its ability to be extended or modified.

Expandability can be evaluated by the effort required for extension or modification and by the duration of the downtime of the system, or parts of the system, being extended.

The addition of process data and application functions as well as the modification of existing functions generally imply an extension or modification of the equipment, as well as of the software.

The expandability of equipment, as a design feature, shall be considered during the initial design and development phase and thus it is important that the requirements be established prior to release of the equipment specifications.

An assessment of expandability should include the following requirements:

- extensions shall require a minimum rearrangement of existing equipment and software;
- extensions or modifications shall not degrade the system reliability, availability and safety;
- system downtime to implement and test the changes shall be minimal.

An instrument for representing and evaluating the expandability of telecontrol equipment is provided in appendix B.

5. Influence of telecontrol equipment on the environment

5.1 *Electrical influence*

5.1.1 *Consumption*

The maximum peak power requirement for each subsystem supply interface shall be identified. It shall be possible to calculate the power requirement for any configuration from the manufacturer's published data.

5.1.2 *Starting current*

Table 9 defines the maximum instantaneous current value i for individual power supply units, with respect to the time t, for $t = 0$, to the steady state condition, $t \geq 2$ s. The parameter I_n is the nominal current value for a d.c. or an a.c. power supply.

Table 9 - Starting current classes

t	i		
	Class S1	Class S2	Class S3
50 µs $\leq t < 1.5$ ms	$i<10$ A if $I_n \leq 1$ A $i<10\ I_n$ if $I_n>1$ A	$i<15$ A if $I_n \leq 1$ A $i<15\ I_n$ if $I_n>1$ A	$i<20$ A if $I_n \leq 1$ A $i<20\ I_n$ if $I_n>1$ A
1.5 ms $\leq t < 30$ ms	$i<10$ A if $I_n \leq 2$ A $i<3\ I_n$ if $I_n>2$ A	$i<15$ A if $I_n \leq 2$ A $i<5\ I_n$ if $I_n>2$ A	$i<20$ A if $I_n \leq 2$ A $i<7\ I_n$ if $I_n>2$ A
30 ms $\leq t < 500$ ms	$i<10$ A if $I_n \leq 3.3$ A $i<3\ I_n$ if $I_n>3.3$ A	$i<15$ A if $I_n \leq 3.3$ A $i<5\ I_n$ if $I_n>3.3$ A	$i<20$ A if $I_n \leq 3.3$ A $i<7\ I_n$ if $I_n>3.3$ A
500 ms $\leq t < 2$ s	$i<1.2\ I_n$	$i<1.2\ I_n$	$i<1.5\ I_n$
$t \geq 2$ s	$i = I_n$	$i = I_n$	$i = I_n$

5.1.3 *Current harmonic distortions*

The current harmonic distortions generated by the telecontrol equipment shall not influence the neighbouring equipment.

- *D.C. supply*

  The maximum peak-to-peak value of the alternating component of the consumed current at low frequencies (<50 kHz) shall be less than the larger of the following values:

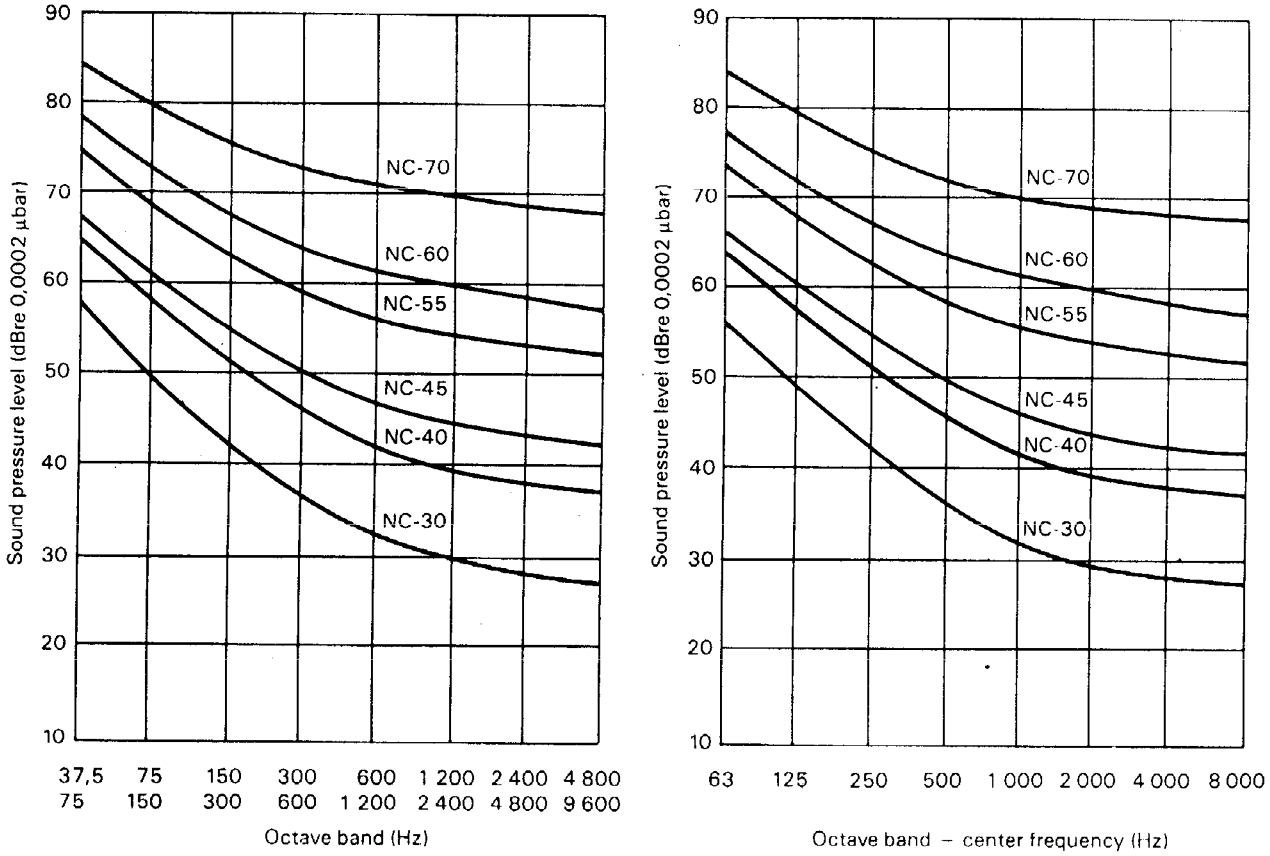
  0.3 I or 250 mA, where I is the consumed current.

- *A.C. supply*

  The maximum current waveform ratio, which is given by the rated peak value/r.m.s. value, shall be less than 5.

2 *Acoustic noise*

Telecontrol equipment which is to be installed in the vicinity of operating personnel, or in an environment where maintenance personnel will be required to work, shall not generate acoustic noise which could cause injury or fatigue to personnel and shall not interfere with voice communication. The two sets of curves given below are extracted from MIL STD 1472.



700/89

Figure 2 - Noise criteria (NC) curves for speech communication

Noise generated by telecontrol equipment shall not exceed NC-30 for control room installations and NC-45 for maintenance area installations.

5.3 *Thermal influence*

Under consideration.

APPENDIX A

MEASURES TO ENHANCE SYSTEM PERFORMANCE

The following measures are intended as guidelines to be referred to during the design, layout and implementation phases.

A.1 Reliability

The system reliability may be improved by taking into account the following points:

- Failure of any component shall not result in loss of functions but only those for which the component is directly needed. In particular, because telecontrol is concerned with monitoring and control of widespread processes, failure of a component at one location shall not cause loss of functions at different locations.

- Failure of any component should not result in an undetected loss of functions.
- To protect against multiple and cascading component failures.

- Functions which are considered vital shall be maintained after failures of single components.
- Telecontrol equipment for power systems shall be sufficiently insensitive to disturbances usually present in them. Nevertheless, if an extreme disturbance results in a short-term malfunction, this shall not lead to permanent malfunction.

- All the routines, including subroutines of the software, shall be debugged before delivery.
- It is important to assess all the conditions which may happen in actual case in programming.
- The load of the CPU in a microprocessor-based telecontrol system should not be too heavy, otherwise failure may take place in some cases.

A.2 Availability

The system availability may be improved through appropriate design features, such as adequate equipment redundancy, as well as through the use of supervisory measures which aim at reporting malfunctions, or which may even automatically adopt measures to ensure continuance of operation. Such measures may include:

- data acquisition function check;
- control function check;
- scan function check;

- poll function check;
- logging function check;
- queue overflow supervision,
- equipment diagnostic aids;
- calibration checks;
- power failure/automatic restart;
- equipment self-check features;
- automatic switchover;
- internal watchdog function;
- data transmission retry feature.

An alarm should be generated whenever a function has automatically or manually been disabled and on failure of any device. All automatic or manual switchover operations of redundant equipment or units shall be logged or otherwise reported.

The data transmission retry feature is activated when a remote station does not receive or respond to a valid message, and enables the transmitting station to repeat the message up to the number of times specified by the retry count. Transient errors such as occasional detected transmission errors or temporary overloads of receiving stations are counted and afterwards reported. Persistent errors or failures initiate appropriate alarms.

The correct operation of the communication channels should be continuously verified either continually, through the normal transmission procedures, or periodically, through special test messages.

A.3 Maintainability

Provisions to enhance the maintainability of equipment include:

- equipment self-tests, diagnostic and trouble shooting procedures to localize any failure or malfunction to the lowest field replaceable unit level;

- readily accessible test and/or break points to facilitate fault isolation; the placement of components on cards shall allow access for test probes and connectors;

- suitable grips or handles to facilitate the safe removal and installation of heavy or bulky units;

- physical provisions to preclude interchange of units or components of a similar form that are not in fact interchangeable;

- physical provisions to preclude improper mounting of units or components;
- provisions (e.g. labels) to facilitate identification and interchange of interchangeable units or components;

- measures to ensure that identification, orientation and alignment provisions include cables and connectors;
- sensitive adjustment points should be located or guarded so that adjustments will not be disturbed inadvertently;
- internal controls should not be located close to dangerous voltages. If such location cannot be avoided, the controls should be appropriately shielded and labelled;
- accessible points under voltage shall be located in such a way as to prevent inadvertent short circuits during mounting, installation or maintenance work;
- the preventive maintenance programme should minimize "wear out" failures;
- the provision for simulation of equipments that are physically remote from the equipment under test.

A.4 Security

In addition to features which enhance system reliability listed under clause A.1, additional procedures shall be implemented in the system structure in order to improve security:

- a single component failure anywhere in the system shall not result in a critical failure (i.e. a failure which is liable to cause injury to persons or significant damage to material);
- use of redundant structures with independent (adaptive) subsystems (covering single functions up to the layout of redundant CPUs);
- avoidance of common mode failures;
- use of preprogrammed special operating procedures (covering local processing and data transport functions);
- local internal interlock in control devices;
- indications of fault locations.

The design of telecontrol systems shall account also for the possible mistakes of the human operator or even for inadvertent operation by the operator or by unauthorized personnel.

A.5 Data integrity

The following requirements and measures are aimed at obtaining correct and complete sets of (monitoring and control) information. In all cases a detected error in a message shall not result in a critical failure of the system. The rate of undetected message errors for critical information transfers, such as commands, shall fulfil the requirements of data integrity class I3.

Measures to improve data integrity are:

- supervision of transmission signal quality;
- transmission code with high redundancy;
- powerful error-detecting facilities;
- appropriate frame synchronization;
- data transmission procedures such as the select and execute command procedure;
- plausibility check;
- repetitive transmissions of identical information;
- state estimation;
- information feedback.

A.5.1 *Monitored information*

Different transmission initiation modes require different classes of data integrity with respect to undetected falsification of monitored information and undetected loss of information. Erroneous information is allowed to have a higher probability in cyclic updating systems than in spontaneous telecontrol systems, because erroneous information is most probably corrected during the following cycles.

In order to limit measurand errors during transducer overload conditions, it is good practice to regard the measuring range as 120% of the nominal range. Greater overloads should be suppressed by the sensors and the transducers and indicated to the user.

A.5.2 *Commands*

Measures against unintended command output shall be taken along the way from initiation at the control centre up to the output in the outstation.

The outstation shall ensure that only the output circuit corresponding to the address transmitted in the message sent by the master station is selected before outputting the command signal.

One method of achieving this is by decoding the command, selecting the output, recoding and comparison. The comparison may be done automatically and should preferably be performed in the master station after transmission of a return information.

Another recommended method is the select and execute command (IEV 371-03-19). A select command causes a preparative output operation in the outstation (selection of the intended output circuit). The effect of this operation is indicated to the operator in the central station by a return information (IEV 371-02-05) upon which the operator may decide to activate the intended operation by input of an execute command or to cancel the operation.

A.6 Time parameters

An important time requirement for state information concerns the overall transfer time, which depends not only on the performance of the telecontrol equipment (procedures of transmission, message length, transmission speed, etc.) but also:

- on the possible number of changes of state in a short period of time;
- on the use which is made of the received state information at the master station;
- on the disturbances on the transmission channels (repetitions, switchings of channels).

One method of defining the conditions for data throughput is to determine the overall transfer time for a single change of state at a particular transmission speed under normal undisturbed conditions.

Another method is to consider the worst case conditions and state the performance in terms of:

- the possible number of changes of state in 1 s;
- the possible number of changes of state in 30 s and the maximum overall transfer time for the last change of state.

In the last case the manufacturer should specify the overall transfer time for the last change of state, given error-free transmission.

Another method is to request the manufacturer to specify the maximum number of events, per time period, that it is possible to transmit, under error-free transmission conditions, without queueing the events.

The limit of sound transmission conditions may be fixed, for example, at a bit error rate smaller than 10^{-4}.

A.7 Accuracy

Monitoring and control of a geographically widespread process requires permanent acquisition of characteristic measured values and integrated totals.

Analog values are therefore converted into digital form before further processing and transmission.

Noise, caused by differences and fluctuations in the electromagnetic field, may be coupled capacitively and/or inductively along the transmission path and corrupt the information signal.

A.7.1 *Analog values*

The method of analog-to-digital conversion should be determined according to the time requirements, accuracy and expected interference.

- Instantaneous value method

This method converts the signal value (information and noise signal) present at a specific instant. Particular care is required with respect to the signal lines and the filtering because, as a consequence of this measuring principle, errors due to series-mode noise are fully reflected in the result. This method is used in all cases where a large number of measuring points have to be scanned rapidly.

- Integrating method

This method supplies the mean value of the input signal over the integration period. It is practical to take as the integration time the reciprocal value of the mains-frequency (or an integer multiple). This method is used for signals with a slow rate of change. The acquisition of measured values from a large number of measuring points in a short period of time can also be accomplished by simultaneous use of several analog-to-digital converters.

- Additional smoothing (before or after conversion) for suppressing short-time measurands changing e.g. from switching operations.

- Additional mean value calculation over a longer period of time (in the range of seconds or minutes).

A.7.2 *Parallel coded information*

These values are already supplied in a code form to the telecontrol equipment. To guarantee the data integrity, measures have to be taken to ensure that the information remains unchanged during acquisition.

A.7.3 *Meter readings*

The following points shall be observed:

- the meter-reading period shall be shorter than the meter overflow time;
- the time base of the meter-reading period shall be accurate;
- all incremental meter pulses shall be detected and processed correctly.

A.7.4 *Overall transfer time*

The information flow is subdivided into several delays from source to destination (some items are not relevant for digital values):

- follow-up time of process equipment, e.g. of transducers;
- information scanning;
- analog-to-digital conversion;

- time delay to transmission caused by:
  - interrogation commands,
  - cyclic or spontaneous transmission,
  - information priority,
  - information coincidence factor,
  - threshold transmission of measurands (see note);

- transfer time, depending on the transmission path, transmission and traffic modes, the required accuracy of the analog values (and thus the necessary word length);

- adjustment and follow-up times of the digital-to-analog conversion;

- follow-up time of the operator's equipment.

Note.- Threshold transmission

Measurands are transmitted only if they change more than given thresholds (min./max.). This technique reduces the amount of data to be transmitted under steady conditions and permits the use of lower transmission speeds, but may affect the accuracy of the measured value.

If the accuracy has to be maintained without increasing the transmission speed, gradient-dependent measuring transmission techniques are recommended.

APPENDIX B

EVALUATION OF EXPANDABILITY

The expandability can be evaluated on the basis of the following tables, which are applicable to both master and remote stations.

The tables should be filled out by the manufacturer with respect to the facilities offered or needed by the equipment, and the downtime (in hours) required to implement and test the relevant modifications. The facilities provided for are given below by the letters A to E. Where several facilities are applicable, e.g. B and C, both should be included in the table.

The tables distinguish between two types of extension:

- extensions in the quantity of process data;
- extensions to the existing application functions.

1) *Quantity of process data*

This type of extension results from an increase in the amount of process data. It involves extensions to the process interface equipment and the relevant software, but excludes additions to existing application functions.

For typical extensions of 20% and 50% with respect to the current system size, the manufacturer should state the facilities required or offered by the equipment, together with the downtime in hours for implementation and test.

Table B.1 - Extensions to process data

Extension to	Extension of			
	.... %		.... %	
	Facility	Time	Facility	Time
Digital inputs Analog inputs Digital outputs Analog outputs Outstations				

Facility

A not possible
B additional equipment wiring needed
C additional software needed
D pluggable unit
E already equipped to the final extent

2) *Application functions*

This type of extension deals with the implementation of additional application functions, such as those used in data processing, together with additional transmission or traffic modes and mainly involves extensions to the existing system software.

Table B.2 - Extensions to application functions

Additional application functions	Remote station		Master station	
	Facility	Downtime	Facility	Downtime
Monitoring functions - Single-point information - Double-point information - Transient information - Binary transformer tap changer positions - Counter pulses - Meter readings - Time tagging - Analog values				
Command functions - Single commands - Double commands - Pulse commands - Setpoint commands				

Facility

A not possible
B requires additional units
C software modifications implemented in the field
D replacement of pluggable software components
E already installed

Table B.3 - Extensions to additional processing functions

Processing functions	Facility	Downtime
Limit processing		
Threshold processing		
Time synchronization		
Switching programs		
Load shedding		
Logging		

Facility

A not possible
B requires additional units
C software modifications implemented in the field
D replacement of pluggable software components
E already installed

Table B.4 - Extensions to data transmission

Transmission mode	Traffic mode			
	Point-to-point traffic		Multi-point traffic	
	Facility	Time	Facility	Time
Cyclic transmission				
Transmission on demand				
Spontaneous transmission				

Facility

A not possible
B requires additional units
C software modifications implemented in the field
D replacement of pluggable software components
E already installed

Printed at Dee Kay Printers. New Delhi, India

Standard Mark

The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act, 1986* to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

Revision of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards Monthly Additions'. Comments on this Indian Standard may be sent to BIS giving the following reference:

Doc : No LT 025 (1582)

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 331 01 31, 331 13 75

Telegrams : Manaksanstha
(Common to all Offices)

Regional Offices :	Telephone
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	331 01 31 331 13 75
Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, Maniktola CALCUTTA 700054	37 84 99, 37 85 61 37 86 26, 37 86 62
Northern : SCO 445-446, Sector 35-C, CHANDIGARH 160036	53 38 43, 53 16 40 53 23 84
Southern : C. I. T. Campus, IV Cross Road, MADRAS 600113	235 02 16, 235 04 42 235 15 19, 235 23 15
Western : Manakalaya, E9 MIDC, Marol, Andheri (East) BOMBAY 400093	632 92 95, 632 78 58 632 78 91, 632 78 92

Branches : AHMADABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR LUCKNOW. PATNA. THIRUVANANTHAPURAM.

Printed at Printwell Printers, Aligarh, India